SCIENCE FOR GLASS PRODUCTION

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WATER RESISTANCE OF MOLDED FLOAT-GLASS SURFACES

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The results of investigations of the water resistance of float glass (both initial and tempered) made by different manufacturers are presented. It is found that heat-absorbing and colorless float glass exhibit asymmetry of the water-resistance of the molded surfaces: the water resistance of the bottom surface is approximately twice as good as that of the top surface. It is shown that the tempering process decreases the water resistance of the glass, and the asymmetry of the water resistance of the surfaces remains. It is concluded on the basis of the results obtained that the water resistance of float glass depends on its chemical composition and the production process parameters.

One of the strength characteristics of sheet glass is its chemical composition, i.e., the ability to withstand the destructive action of different reagents: acids, alkali, and water. It is well known that the chemical resistance of glass depends on its chemical composition. Thus, silicon dioxide substantially increases the chemical resistance of glass but, as a rule, alkali oxides decrease it.

The chemical resistance of glass is also characterized by the state of its surface — it is higher for articles with a fire-polished surface than for mechanically worked glasses with the same composition, on whose surfaces microcracks form.

In addition, the chemical resistance largely depends on the past temperature and the character of the medium with which the glass was in contact during formation and annealing, i.e., on the glass production technology [1, 2]. Since during use glass articles come into contact with a wet medium (glass containers, automobile and window glass, and so forth), the most important indicator of chemical resistance of glass is water resistance.

It is well known that the surfaces of float glass are formed in different media — the top surface interacts with the gaseous protective atmosphere and the bottom surface interacts with a tin melt, which produces an asymmetry of the physical – chemical properties of the molded surfaces. Consequently, it is of scientific and practical interest to study the water resistance of the top and bottom surfaces of the glass separately.

In our work the water resistance of molded glass surfaces was determined by a method, developed at the Saratov Institute of Glass, using a specialized apparatus (see Fig. 1).

This apparatus consists of a quartz cylinder to whose ends the glass sample to be analyzed is hermetically secured. The cylinder is filled with distilled water, connected with the reverse refrigerator, and placed on an electric plate, where

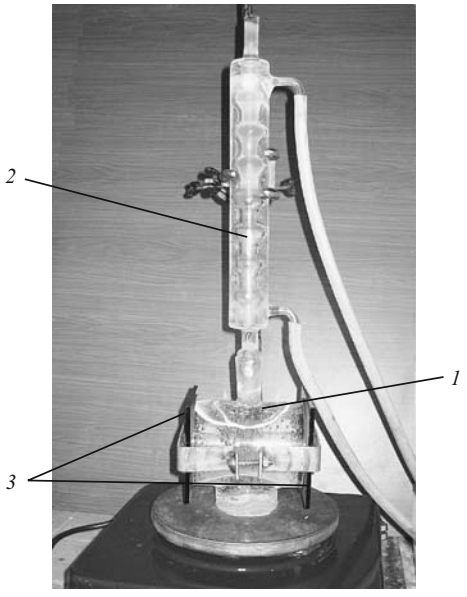

Fig. 1. Apparatus for determining the water resistance of molded glass surfaces: *1*) cylinder with distilled water; *2*) reverse refrigerator; *3*) glass samples.

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TABLE 1.

Manufacturer	Glass	Water resistance, mg Na_2O/dm^2		Asymmetry coefficient
		top surface	bottom surface	
Borskii Glass Works JSC	Colorless	0.1626	0.0920	1.7
Saratov Institute of Glass JSC	Heat-absorbing:			
	gray	0.2920	0.1008	2.9
	bronze	0.2273	0.1391	1.6
	bronze without SO_2 treatment	0.2325	0.2310	1.0

the water boils for a certain period of time. The solution obtained is studied in flame-photometric fluid analyzer. The water resistance of the glass is determined by the amount (mg) of sodium oxide (Na_2O) transferred into the solution from unit surface area (1 dm^2) of the glass samples. The smaller mg Na_2O/dm^2, the greater the water resistance of the glass is.

To compare the water resistance of the molded surfaces of float glass we studied samples of bronze and gray colored heat-absorbing glass manufactured by Saratov Institute of Glass JSC and colorless glass manufactured by the Borskii Glass Works JSC.

It is well known that in the course of the production of float glass its bottom surface is treated with sulfur dioxide SO_2. In the course of the experimental work, performed on the float time of the Saratov Institute of Glass JSC, a batch of 4.0 mm thick bronze-colored glass which was not treated with SO_2 was obtained. The samples of this glass were also tested for water resistance. The results are presented in Table 1.

For the SO_2-treated heat-absorbing glass and the colorless glass manufactured by the Borskii Glass Works it was found that the water resistance of its molded surfaces exhibits asymmetry: the water resistance of the bottom surface is, on average, two times better than that of the top surface. For the heat-absorbing glass which was not treated with SO_2 the values of the heat resistance of both surfaces are the same (the asymmetry coefficient is 1).

The experiment performed showed that the treatment of the float glass with SO_2 improves the water resistance of the bottom surface of the glass by a factor of approximately 1.5.

In addition, the colorless glass has a higher water resistance than the heat-absorbing glass (by a factor of 1.3 – 2.5). This could possibly be explained by the different content of silicon dioxide and alkali oxides in the glass (Table 2).

Thus, our results confirm the published data on the effect of the chemical composition and production process parameters of glass on its chemical resistance.

It should be noted that float glass is being increasingly used as a construction material and it freely withstands different operational loads. Most often, quenched glass is used for this purpose (the demand for such glass in Russia is 10^6 m^2/year). Consequently, the investigations of the strength properties of quenched glass are of practical interest.

To compare the chemical resistance of glass we measured the water resistance of its molded surfaces before and after tempering. The tests were performed on 0.5 mm thick samples of heat-absorbing (gray and bronze colored) and colorless glass (Table 3).

The coefficient of change of the water resistance was calculated as the ratio of the water resistance of the tempered glass to that of the initial (before tempering) glass.

The investigations showed that the water resistance of the molded surfaces of the tempered glass (both heat-absorbing and colorless) is 1.5 times worse than that of the initial glass. These results confirm the published data: water and a humid atmosphere destroy tempered 1.2 – 2 times more strongly that well-annealed glass [3].

As one can see form the data in Table 3, the existing asymmetry of the water-resistance of the top and bottom surfaces of the heat-absorbing glass and colorless glass manufactured by the Borskii Glass Works was the same after tempering.

The results obtained on the chemical resistance of float glass are of great practical value. For example, the asymmetry of the water resistance of the surfaces of sheet glass must

TABLE 2.

Manufacturer	Glass	Mass content, %						
		SiO_2	Al_2O_3	$Na_2O + K_2O$	CaO	MgO	Fe_2O_3	SO_3
Borskii Glass Works JSC	Colorless	72.55	1.13	13.27	8.68	3.93	0.10	0.32
Saratov Institute of Glass JSC	Heat-absorbing:							
	bronze	71.48	1.41	13.71	8.78	3.71	0.33	0.40
	gray	71.73	1.40	13.75	8.74	3.87	0.28	0.36

TABLE 3.

Manufacturer	Glass	Water resistance, mg Na_2O/dm^2				Coefficient of change of the water resistance	
		initial glass		tempered glass			
		top surface	bottom surface	top surface	bottom surface	top surface	bottom surface
Borskii Glass Works JSC	Colorless	0.1626	0.0920	0.2358	0.1408	1.46	1.53
Saratov Institute of Glass JSC	Bronze	0.2273	0.1391	0.2773	0.2126	1.22	1.53
	Gray	0.2920	0.1008	0.3067	0.2126	1.05	2.10

be taken into account when it is mounted and when construction pieces are manufactured from it. It should be noted that when glass articles are in use (glass containers, basins, aquariums) it is the bottom surface, being the most stable, that should be in contact with moisture. The top surface of float glass, being mechanically stronger, should be in the tension zone but, when possible, not in contact with a wet medium.

The decrease of the water resistance of glass found to occur after the glass is tempered and the substantial asymmetry of the water resistance of the molded surfaces place on the list of topical problems the problem of increasing the chemical resistance of float glass at the time it is being manufactured.

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